HYDROGEN
JURNAL KEPENDIDIKAN KIMIA
https://e-journal.undikma.ac.id/index.php/hydrogen/index

August 2024. 12(4)
e-ISSN: 2656-3061
p-ISSN: 2338-6487
pp. 697-707

Chemical Concepts Related to the Context of Palm Oil Production Process for Contextual Chemistry Learning based on Local Natural Resources

Syifa Yulia Shalsabila, Pintaka Kusumaningtyas*, Farah Erika
Department of Chemistry Education, Faculty of Teacher Training and Education, Mulawarman University of Education, Jl. Muara Pahu Gn. Kelua Kec. Samarindaa Ulu, Kota Samarinda, Kalimantan Timur, Indonesia 75242
* Corresponding Author e-mail: pintaka@fkip.unmul.ac.id

Article History
Received: 09-05-2024
Revised: 14-08-2024
Published: 31-08-2024

Keywords: chemical concept, contextual chemistry learning, palm oil, production process, local natural resource

Abstract
Chemistry learning oriented to local natural resources around students presents real situations that can help students to understand the concepts of learning material being studied. This research aims to identify the chemical concepts involved in the process of palm oil production for developing contextual chemistry learning materials based on local natural resources. This research used descriptive quantitative research. Data were collected from field observation, literature study and documentation study. The relevance of chemical concepts and the context of palm oil processing were assessed by the validators. Based on the finding, there are 3 chemical concepts related to the palm fruit processing into crude palm oil (CPO), namely: classification of matter, change of matter, and separation of mixture. The relationship between both of these three chemical concepts and the context of palm oil processing has been declared highly valid with a score of 3.75 by the validators. Therefore, the processing of palm fruit into CPO can be used as a learning resource for contextual chemistry learning material in the implementation of Merdeka curriculum at phase E.

How to Cite: Shalsabila, S., Kusumaningtyas, P., & Erika, F. (2024). Chemical Concepts Related to the Context of Palm Oil Production Process for Contextual Chemistry Learning based on Local Natural Resources. Hydrogen: Jurnal Kependidikan Kimia, 12(4), 697-707. doi:https://doi.org/10.33394/hjkk.v12i4.11520

https://doi.org/10.33394/hjkk.v12i4.11520

INTRODUCTION

Learning is a two-way communication process between teachers and students. According to Law No.20 of 2003 article 1 paragraph 20 concerning the National Education System, it is stated that learning is an interaction between students and educators to learning resources in a learning environment. Learning resources have an important role in determining the learning process so that learning becomes effective and efficient in achieving a goal (Irwandi & Fajeriadi, 2020). Jailani (Jailani, 2017) stated that teachers are not the only source of learning, because there are various other learning resources that can be used by teachers to support the learning process. Therefore, teachers must be able to optimally utilize the various learning resources that exist around students' lives in learning. The use of learning resources in students' surroundings is very much in line with the characteristics of a Merdeka curriculum, namely flexible and focused on essential material. In implementing the Merdeka curriculum, teachers are given the freedom to carry out differentiated learning according to students' abilities and make adjustments to the local context and content around the students. The environment around students can bring students directly into contact with the objects being studied, thereby increasing student learning productivity (Irwandi & Fajeriadi, 2020).

(Aini & Adiyono, 2023) stated that the Independent Curriculum seeks to respond to the challenges faced by students in an education system which is often burdened by many

assignments and dense material. In traditional systems, students are often faced with excessive assignments and material that must be mastered in a short time, which can result in stress and fatigue (Anisa, 2022). The dense material and assignments that must be completed often reduce the time and space for students to think critically and creatively (Hakim & Nabila, 2022). As a result, learning becomes an activity that focuses more on fulfilling assignments and achieving academic grades, rather than a comprehensive self-development process. The Merdeka Curriculum offers significant changes by reducing the burden of excessive assignments and materials, which have been obstacles for students to develop their potential optimally (Heatubun & Talaud, 2024). This reduction is intended to provide more space for students to explore their interests and abilities more freely and in depth. When students are less burdened with routine, often mechanical tasks, they have more opportunities to engage in activities that stimulate creativity and higher-order thinking.

It is important to note that higher-order thinking skills include the ability to analyze, evaluate, and create something new based on existing knowledge (Liline et al., 2024). These abilities are critical in facing the complex challenges of the 21st century, where students need to not only memorize information, but also understand, apply, and manipulate that knowledge in diverse contexts. By giving students the freedom to explore and discover for themselves, the Merdeka Curriculum encourages them to think more deeply and critically (Abrami et al., 2015; Alsaleh, 2020). However, this reduction in assignments and materials must be balanced with effective learning strategies from teachers. Teachers need to ensure that even though the number of assignments and materials is reduced, the quality and depth of learning is maintained. One way is to implement a project or problem-based learning approach, where students are invited to integrate various concepts and skills in contexts that are relevant to real life. In this way, students not only memorize the material, but also develop critical, creative and problem-solving thinking skills (Belecina & Jose M Ocampo, 2018). The freedom given to students in the Independent Curriculum also requires wise supervision from teachers, so that this freedom is not misused or becomes counter-productive. The teacher as a facilitator has an important role in directing student exploration so that it remains on a constructive path and in accordance with learning objectives.

Chemistry as a part of natural Science (IPA) has a context that is very close to real everyday life, because everything in life cannot be separated from chemistry. Pradietha dkk. (Pradietha et al., 2014) revealed that chemistry learning can be more realistic if teachers use learning resources that exist in the environment around students. Learning chemistry also cannot be separated from nature as a learning source. This is because studying chemistry not only studies the natural environment, but also the processes that take place within it. Chemistry learning in schools aims to provide students with knowledge, ideas and concepts about the local potential of the natural surroundings obtained from experience through various scientific processes (Istiani & Retnoningsih, 2015). Chemistry learning emphasizes direct experience to develop students' competencies so they are able to understand and utilize the potential of the surrounding natural environment through the application of chemical concepts in processing technology. Learning that is oriented towards local natural resources around students presents real situations that can help students understand the concepts of the material being studied (Rangga et al., 2023). According to Yakina dkk (Yakina et al., 2017), chemistry learning emphasizes understanding chemical concepts, technological product results related to the chemical industry, and chemical applications in everyday life.

Indonesia is the world’s leading producer of palm oil and supplies more than half of the palm oil global market. Palm oil production in Indonesia has increased by 400 percent over the past two decades (USDA, 2023). Most of the Indonesian palm oil is produced in Sumatra and Kalimantan (Schleicher et al., 2019). Accordingly, palm oil is local natural resources in these both provinces in Indonesia. In the context of chemistry learning, the application of chemical

concepts cannot be separated from the processing of palm fruit into palm oil. Integrating the context of palm oil production process into chemistry learning is very interesting to implement in schools located in areas around palm oil processing factories, so that learning becomes more meaningful because students can see directly the process of palm oil production. This knowledge will also be very useful for students in the area as preparation if they will work in palm oil processing factories in the future. Therefore, this research aims to identify chemical concepts in the process of palm oil production which are in accordance with learning outcomes in chemistry subjects in the Merdeka curriculum. Hopefully, the results of this concept analysis will be useful for chemistry teachers in developing contextual chemistry learning materials for chemistry learning in high schools located in palm oil industrial areas.

METHOD

This research is a quantitative descriptive study that reveals chemical concepts in the independent curriculum chemistry learning outcomes that are relevant to the palm oil processing. This research was carried out through field observation, literature study, documentation study, and questionnaire method. The stages in this research include: (1) field observation to collect data regarding the process of palm oil production at factories located near SMAN 1 Muara Badak and SMAN 2 Muara Badak, Kutai Kartanegara district, (2) identifying and obtaining the explanations about the chemical concepts in the context of palm oil production through literature study, (3) analyzing chemistry learning outcomes in the independent curriculum and flow of learning objective used by teachers in schools near palm oil industrial areas through documentation study, and (4) assessing the relevance of content and context of palm oil production with competencies in chemistry learning outcomes in the independent curriculum using questionnaire instruments. The flow of the stages of this research can be seen in Figure 1.

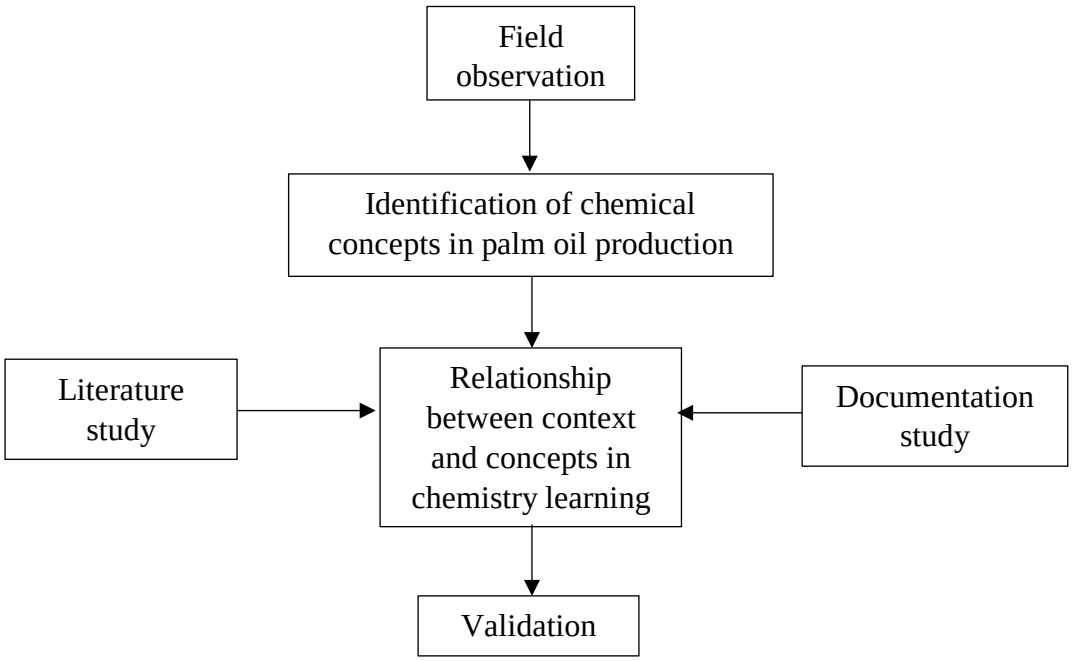


Figure 1. The flowchart of research stages

The data validity of relationship between context of palm oil production process and concepts in chemistry learning is obtained by using the validation sheet. The validator will provide an assessment on a 1–4 scale on each context of palm oil production processes. The average value obtained from 2 validators is confirmed by using the validity level criteria in the following Table 1.

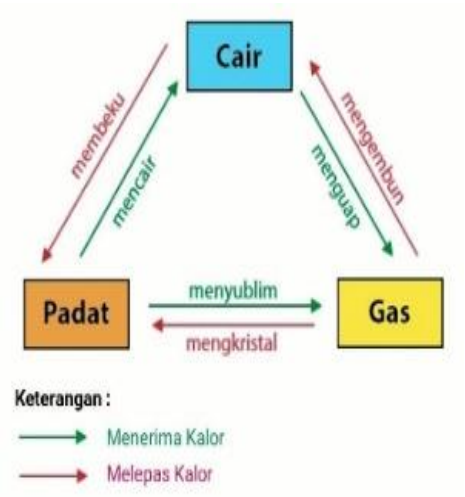
Table 1. Criteria for level of validity

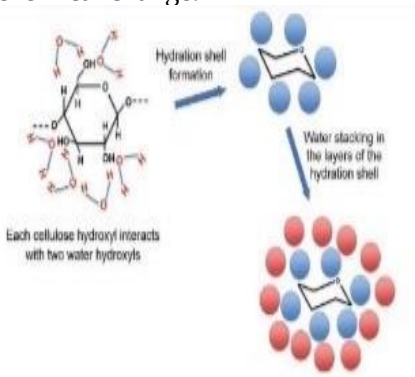
Range	Category
1.00 – 1.99	Invalid
2.00 – 2.99	Less valid
3.00 – 3.49	Valid
3.50 – 4.00	Highly valid

RESULTS AND DISCUSSION

Based on the field observations at palm oil processing factories, the stages in processing palm fruit into CPO consist of: (1) boiling, (2) threshing, (3) crushing (pulverizing), (4) oil extraction, and (5) clarification (refining). The results of the literature study show that the process of palm fruit processing into CPO involves several concepts and processes of chemistry studied in the school. The process of boiling and pulverizing were related to the concept of material changes, the oil extraction related to the classification of matter and separation of mixture, and clarification were related to the separation of mixture. There was no chemical concept related to the threshing process because the thresher process only functions to release palm fruit from palm bunches. A brief explanation of the relationship between the stages in processing palm fruit into CPO with chemical concepts is outlined in Table 2.

Table 2. The relationship between the stages in processing palm fruit into CPO with chemistry subject matter

No.	Context in palm oil processing	The relationship between chemical concepts and palm oil processing	Chemical concept in chemistry learning
1.	**Boiling Process** Boiling process of fresh fruit bunch (FFB) is carried out by using water vapor in sterilizer. The boiling process aims to inactivate hydrolytic enzymes that can increase the content of free fatty acids (FFA) in CPO.	The production of water vapor used in a sterilizer involves changing the state of water (liquid) into water vapor (gases): $H_2O_{(l)} \rightarrow H_2O_{(g)}$	The change in the state of a liquid into a gas is a physical change, and the process is called evaporation. 

2.	**Thresher Process** The thresher process functions to release palm fruit from palm bunches by lifting and pressing them onto the empty palm bunch conveyor.	-	-
3.	**Crushing Process using Digester** In digester, palm fruit is reheated at a temperature of 95–100^{o}C for 20 min to separate the pericarp from the core, and break down the oil cell before extraction.	The digester function to chop oil palm fruit until the fruit flesh becomes smoother, making it easier to contact with water. In digester process, hot water vapor is used to facilitate the crushing process because this water vapor can hydrate cellulose in fruit flesh until swelling up (Etale et al., 2023). In addition, heat treatment cause cell wall breakdown, so the fiber in the bunch and fruit becomes smoother (Nasharudin et al., 2023), making it easier to be separated from the nut.	Hydration is a process in which ions are surrounded by water molecules arranged in a certain state. In this context, water molecules form hydrogen bonding with hydroxyl group in cellulose. The hydration process and cell wall breakdown included the chemical change. 
4.	**Oil extraction using screw press** The basic concept of screw press machine involves the principle of compression and separation. During compression, hot water is added to the screw press machine to facilitate in out of oil from fiber and nut. Compressed FFB will produce separated two groups of products, those are: (1) a mixture of water, oil, and non-oil solids (NOS), and (2) cake containing fiber and nut.	In mechanical extraction using screw press machine, palm fruit is pressed to out the oil. In pumping Crude Palm Oil in palm oil mills, problems are often found in the fluid's viscosity (Amelia & Akhyan, 2022). Therefore, hot water is added into the screw press machine to decrease the viscosity of crude oil so it can flow and out from palm fruit easier. Oil is a mixture containing saturated and unsaturated fatty acids (Mancini et al., 2015); (Almeida et al., 2021)). Saturated fatty acids have a higher melting point than unsaturated fatty acids, so the state of saturated fatty acid is solid, and unsaturated fatty acid is liquid in room temperature. Therefore,	Oils are liquid in room temperature due to the presence of higher percentage of unsaturated fatty acids (oleates). Mixtures are formed when two or more substances (elements or compounds) mix together without participating in a chemical change. There are two primary types of mixtures, namely homogeneous mixtures and heterogeneous mixtures. Crude oil that out of screw press machine is an example of heterogeneous mixture. A heterogeneous mixture is a mixture of two or more chemical substances (elements or compounds) where the different components can be visually distinguished and easily separated by physical means. There are two main types of heterogeneous mixture: suspension and colloids. Crude oil that out from screw press machine is an example of suspension, because the particles of the solute do not dissolve in the solvent rather they remain suspended in bulk throughout. The size of particles of suspension is large enough to be visible from naked eyes.

		high temperature (90–95^{o}C) is used during extraction to extract all of oil components contained in palm fruit. The crude oil that out from screw press machine are a heterogeneous mixture because this mixture consist of distinct substances (water, oil, and non-oil solid). The component of crude oil does not blend together into a uniform whole but remain separate from each other and unevenly distributed throughout the mixture.	
5.	**Clarification process** The extracted crude oil contains oil, water, and non-oil solids (NOS). To separate water and NOS from crude palm oil (CPO), several separation process were done, those are: (1) Separating sand and other coarse materials using **Sand Trap Tank**. (2) Filtering CPO from the remaining fibers and other dirty oil using **vibrating screen**. (3) Sewage sludge (dirty oil or mud) was separated from the oil by gravity using a C**ontinuous Settling Tank (CST)**. At this stage, the oil settled at the tank flows to the sludge tank to be further treated to have more oil extracted from it. While the crude	Clarification is the process that ensures removal of all impurities from the crude oil. Due to the characteristic of heterogeneous mixture, crude oil can be separated by physical mixture separation methods, as follows: (1) Separating oil from NOS using a sand trap tank works based on gravity by settling. The impurity solids (sand) will settle at the bottom of the tank, while the crude oil will rise to the top. This type of mixture separation is decantation method. (2) Separation of fibers from CPO in vibrating screen works based on filtration method. (3) Separation of CPO from sludge (non-oil solid, NOS) in CST is based on the differences of specific gravity. Oil with a specific gravity < 1 will be in the top layer and water with a specific gravity = 1	Types of physical mixture separation methods: (1) Decantation is a separation method to separate the components of a mixture of solids and liquids by settling. (2) The filtration method is the separation of the components of a mixture by using a filter which is based on the difference in particle size between the solvent and the solute. (3) Centrifugation is a separation process using centrifugal force as a driving force. Separation can be carried out between suspended solid liquid phases and liquid-liquid phase mixtures. Separation of two liquid phases can be carried out if the two liquids have different mass densities. (4) Vacuum drying is a evaporation process carried out in a vacuum evaporator. This evaporator works at a pressure below atmospheric pressure, so that the boiling point at the solvent can be lowered thereby speeding up the evaporation process.

	oil on the upper part of the tank goes to the oil purifier.	will be in the middle layer, while NOS impurities with a specific gravity > 1
(4)	Crude oil in **oil purifier** combined with the recovered oil from the sludge tank was then purified by using centrifugation. This stage is to remove the remaining solid that are commonly smaller and finer. The centrifuges have an automatic cake discharge and cleaning system.	will be in the bottom layer. This separation process used the principle of decantation. (4) Separation of CPO from water in oil purifier used the working principle of centrifugal. Oil with lower mass densities will be in the top layer, while water with higher mass densities will be in the bottom layer.
(5)	Reducing the water content in CPO using **vacuum dryer**.	(5) Trace water content in oil was also reduced using vacuum drying to prevent oxidation process of oil during drying process.

Table 3. Validation results of chemical concept in chemistry learning related to the context of palm oil processing

No.	Chemical concepts releated to the context of palm oil processing	Average Score	Category
1.	Boiling process of FFB related to the chemical concept of the change of matter, those are the physical change (the change of water to water vapour)	4.00	Highly valid
2.	Crushing process using digester related to the chemical concept of the change of matter, those are chemical change (change of FFB to palm fruit pulp)	3.50	Highly valid
3.	Oil extraction using screw press machine related to the chemical concept of mixture separation and classification of matter.	3.50	Highly valid
4.	Clarification process related to the chemical concept of mixture separation, including physical separation (filtration, evaporation) and chemical separation (decantation, centrifugation).	4.00	Highly valid
	Total	15.00	Highly valid
	Average	3.75	

Based on the explanation in Table 2, there were 3 chemical concepts related to the context of palm oil processing, those are: (1) the change of matter (physical and chemical changes), (2) classification of matter (heterogeneous mixture), and (3) separation of mixture. These three chemical concepts have been validated by experts and declared highly valid with the average

validity score of 3.75. Table 3 is outlined the results of the validation of context of palm oil processing and chemical concepts in chemistry learning.

The concept of classification of matter, change of matter, and separation of mixture are found in the learning outcomes of Merdeka Curriculum at phase D in the subject of science and at phase E in the subject of natural and social science projects. The context of the process of processing palm oil into CPO can also be provided in chemistry learning in phase E, namely in the elements of chemical understanding regarding the application of chemical concepts in everyday life. In chemistry learning in phase E, students can be asked to identify chemical concepts related to the context of palm oil processing based on the initial knowledge that students have in phase D. Learning that presents real world situations, such as the palm oil processing process, can motivate students to be able to connecting knowledge and its application in everyday life. This is in line with (Majid & Rohaeti, 2018) and (Getu et al., 2024) who stated that context-based chemistry learning influences student learning outcomes and attitudes.

The Merdeka Belajar curriculum demands a more active role for teachers as facilitators in the student learning process. In this paradigm, teachers are no longer just the main source of knowledge that students must memorize, but play a greater role in guiding students to develop critical, creative and independent thinking abilities. By becoming a facilitator, teachers provide wider space for students to explore, understand and apply knowledge in real life contexts. The Merdeka Curriculum was designed to overcome the problems of the previous curriculum which was often considered too dense and burdened students with a lot of material, but did not provide enough space for creativity and innovation (Anisa, 2022). Students are often trapped in tiring study routines, focusing on mastering theory without understanding its application in everyday life (Aini & Adiyono, 2023). As a result, although students may get good grades in exams, they are often ill-prepared to face the complex challenges of this century. 21st, such as the ability to adapt to change, work together in teams, and solve problems creatively (Almazroui, 2023, 2023; Hulyadi et al., 2024).

(Anisa, 2022) states that in the context of the Independent Learning Curriculum, students are given the freedom to learn according to their respective interests, talents and speed. (Jones & Dexter, 2014) report that teachers as facilitators are tasked with supporting and guiding this learning process by providing the necessary resources, encouragement and feedback. Teachers also need to create a conducive learning environment, where students feel safe to experiment, make mistakes, and learn from these mistakes (Goodyear & Dudley, 2015). In addition, the Merdeka Curriculum encourages learning based on real projects and problems, which allows students to connect theoretical knowledge with real-world situations (Alexander et al., 2014; Almazroui, 2023; Almulla, 2020). For example, in studying chemistry, students can be invited to study the process of processing palm oil into CPO, and how the chemical concepts they learn are applied in this industry. This kind of approach not only makes learning more relevant and interesting, but also helps students develop skills needed in the 21st century, such as critical thinking, problem solving, and collaboration (Anazifa & Djukri, 2017; Birgili, 2015; Carlgren, 2013).

Contextual learning is the essence of implementing the Independent Curriculum which directs learning so that students are aware of real phenomena faced in society. (Minata et al., 2022) stated that context-based chemistry learning has a positive influence in improving students' cognitive, affective, psychomotor and social aspects. Through contextual learning, students not only understand the material theoretically, but are also able to understand the benefits of studying the material in everyday life (Suhartoyo et al., 2020). Chemical concepts related to the context of palm oil processing can also be developed as teaching materials in local content subjects for schools in areas that have potential for the palm oil industry. In the

development of local content curriculum, chemical concepts related to the context of palm oil processing can be used as curriculum materials for supporting and guiding the process of knowledge integration with local natural resources. Thus, the Merdeka Belajar Curriculum offers a more humanistic and holistic approach, aiming to equip students with knowledge and skills that are relevant for their current and future lives. Teachers as facilitators play a key role in supporting students to become independent, creative learners and ready to face the challenges of the 21st century.

CONCLUSION

Based on the research findings, it can be concluded that there were 3 chemical concepts related to the context of palm oil processing, those are: (1) the change of matter (physical and chemical changes), (2) classification of matter (heterogeneous mixture/suspension), and (3) separation of mixture (extraction, decantation, filtration, centrifugation, and vacuum drying). The relevance of three chemical concepts with the context of palm oil processing was declared highly valid by expert validators, so it can be used as a resource for learning chemistry in Merdeka curriculum at phase E.

RECOMMENDATIONS

The implication of this research can be a reference in developing contextual chemistry teaching materials in local content subjects for schools in areas that have potential for the palm oil industry.

ACKNOWLEDGEMENTS

Thanks to all those who have contributed to this research, especially for Dr. Agung Rahmadani, M.Sc. and Nisaa Ul Khairiyyah, S.Pd. as validators in this research.

BIBLIOGRAPHY

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for Teaching Students to Think Critically: A Meta-Analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Aini, Q., & Adiyono. (2023). Implementation of an Independent Curriculum in Supporting Students' Freedom to Create and Learn. *Journal of Scientific Research, Education, and Technology (JSRET)*, *2*(3), Article 3. https://doi.org/10.58526/jsret.v2i3.187

Almeida, E. S. de, Damaceno, D. da S., Carvalho, L., Victor, P. A., Passos, R. M. dos, Pontes, P. V. de A., Cunha-Filho, M., Sampaio, K. A., & Monteiro, S. (2021). Thermal and Physical Properties of Crude Palm Oil with Higher Oleic Content. *Applied Sciences*, *11*(15). https://doi.org/10.3390/app11157094

Alsaleh, N. J. (2020). Teaching Critical Thinking Skills: Literature Review. *Turkish Online Journal of Educational Technology - TOJET*, *19*(1), 21–39.

Amelia, B., & Akhyan, A. (2022). Experimental Study of the Effect of Crude Palm Oil (Non-Newtonian Fluid) Viscosity on Increasing Flowrate Capacity. *Proceeding International Applied Business and Engineering Conference*, 141–148.

Anisa, D. L. N. (2022). Implementation of Independent Learning Curriculum As a 21st Century Learning Model in Higher Education. *MANAGERIA: Jurnal Manajemen Pendidikan Islam*, *7*(2), Article 2. https://doi.org/10.14421/manageria.2022.72-15

Belecina, R. R., & Jose M Ocampo, J. (2018). Effecting Change on Students' Critical Thinking in Problem Solving. *EDUCARE*, *10*(2), Article 2. https://doi.org/10.2121/edu-ijes.v10i2.949

Etale, A., Onyianta, A. J., Turner, S. R., & Eichhorn, S. J. (2023). Cellulose: A Review of Water Interactions, Applications in Composites, and Water Treatment. *Chemical Reviews*, *123*(5), 2016–2048. https://doi.org/10.1021/acs.chemrev.2c00477

Getu, G. tsadik, Mebrahitu, G. kidan, & Yohannes, G. (2024). Effects of Context-Based Teaching Chemistry on Students' Achievement: A Systematic Review. *Jurnal Pijar Mipa*, *19*(2), 190–197. https://doi.org/10.29303/jpm.v19i2.6458

Hakim, A. R., & Nabila, M. (2022). Implementation of The Independent Learning Curriculum in Cirebon District. *Journal of Social Science*, *3*(5), Article 5. https://doi.org/10.46799/jss.v3i5.438

Heatubun, A., & Talaud, F. (2024). Implementation of the Freedom to Learn Curriculum and Its Impact on the Achievement. *EDUTEC : Journal of Education And Technology*, *7*(3), Article 3. https://doi.org/10.29062/edu.v7i3.786

Irwandi, & Fajeriadi, H. (2020). Pemanfaatan Lingkungan sebagai Sumber Belajar untuk Meningkatkan Minat dan Hasil Belajar Siswa SMA di Kawasan Pesisir, Kalimantan Selatan. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *1*(2), 66. https://doi.org/10.20527/binov.v1i2.7859

Istiani, R. M., & Retnoningsih, A. (2015). Pemanfaatan Lingkungan Sekolah Sebagai Sumber Belajar Menggunakan Metode Post To Post Pada Materi Klasifikasi Makhluk Hidup. *Journal of Biology Education*, *4*(1), 70–80.

Jailani, M. sahran. (2017). Pengembangan Sumber Belajar Berbasis Karakter Peserta Didik (Ikhtiar optimalisasi Proses Pembelajaran Pendidi-kan Agama Islam (PAI)). *Nadwa: Jurnal Pendidikan Islam*, *10*(2), 175–192. https://doi.org/10.21580/nw.2016.10.2.1284

Liline, S., Tomhisa, A., Rumahlatu, D., & Sangur, K. (2024). The Effect of the Pjb-HOTS Learning Model on Cognitive Learning, Analytical Thinking Skills, Creative Thinking Skills, and Metacognitive Skills of Biology Education Students. *Journal of Turkish Science Education*, *21*(1), 175–195.

Majid, A. N., & Rohaeti, E. (2018). The Effect of Context-Based Chemistry Learning on Student Achievement and Attitude. *American Journal of Educational Research*, *6*(6), 836–839. https://doi.org/10.12691/education-6-6-37

Mancini, A., Imperlini, E., Nigro, E., Montagnese, C., Daniele, A., Orrù, S., & Buono, P. (2015). Biological and nutritional properties of palm oil and palmitic acid: Effects on health. *Molecules*, *20*(9), 17339–17361. https://doi.org/10.3390/molecules200917339

Minata, Z. S., Rahayu, S., & Dasna, I. W. (2022). Context-Based Chemistry Learning: A Systematic Literature Review. *Jurnal Pendidikan MIPA*, *23*(4), 1446–1463. http://dx.doi.org/10.23960/jpmipa/v23i4.pp1446-1463.

Nasharudin, N. A. M., Sulaiman, N. F., Mohammad, N. A., Jaafar, W. N. R. W., & Dr., F. A. (2023). The Effect of Heat Treatment and Chemical Treatment on Natural Fibre to The Durability of Wood Plastic Composites – A Review. *Journal of Materials Exploration and Findings*, *2*(2). https://doi.org/10.7454/jmef.v2i2.1023

Pradietha, E. T., Meilinda, M., & Nazip, K. (2014). Identifikasi Materi Lokal Sebagai Sumber Belajar Sains Biologi SMP di Kabupaten Muara Enim. *Jurnal Pembelajaran Biologi: Kajian Biologi Dan Pembelajarannya*, *1*(2), 115–126.

Rangga, B. E., Lidi, M. W., Daud, M. H., & Wolo, D. (2023). Student Field Trip to Mangrove Forests: The Effect On Learning Outcomes. *Inornatus: Biology Education Journal*, *3*(2), 60–66. https://doi.org/10.30862/inornatus.v3i2.416

Schleicher, T., Hilbert, I., Manhart, A., Hennenberg, K., Ernah, Vidya, S., & Fakhriya, I. (2019). Production of Palm Oil in Indonesia: Country-focused Commodity Analysis in the Context of the Bio-Macht Project. In *Final Report Project-ID: 031B0235B*.

Suhartoyo, E., Wailissa, S. A., Jalarwati, S., Samsia, S., Wati, S., Qomariah, N., Dayanti, E., Maulani, I., Mukhlish, I., Rizki Azhari, M. H., Muhammad Isa, H., & Maulana Amin, I. (2020). Pembelajaran Kontekstual Dalam Mewujudkan Merdeka Belajar. *Jurnal Pembelajaran Pemberdayaan Masyarakat (JP2M)*, *1*(3), 161. https://doi.org/10.33474/jp2m.v1i3.6588

USDA. (2023). Indonesia Palm Oil: Historical Revisions Using Satellite-Derived Methodology. In *Commodity Intelligence Report* (Vol. 19, Issue November 9).

Yakina, Y., Kurniati, T., & Fadhilah, R. (2017). Analisis Kesulitan Belajar Siswa Pada Mata Pelajaran Kimia Kelas X Di Sma Negeri 1 Sungai Ambawang. *AR-RAZI Jurnal Ilmiah*, *5*(2), 287–297. https://doi.org/10.29406/arz.v5i2.641